

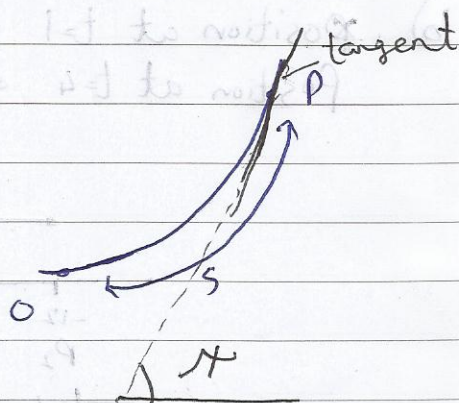
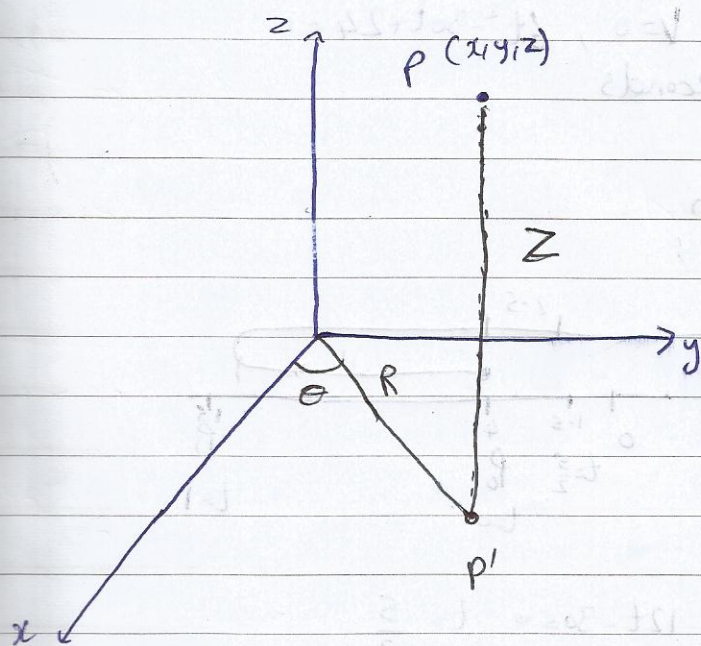
# Introduction to dynamics

Dynamics is split into 2 parts:

1. Kinematics: It deals with position, velocity and acceleration of the object (particle/rigid body)
2. Kinetics: It deals with the forces acting on the object.

- We have 3 types of coordinates

1. Rectangular coordinates  $(x, y, z)$
2. Cylindrical coordinates  $(R, \theta, z)$
3. Intrinsic coordinates  $(s, \pi)$



## Rectilinear motion



$$\text{displacement} = (x + \Delta x) - x = \Delta x$$

$$\leftarrow \frac{x + \Delta x}{t + \Delta t} \rightarrow$$

$$\text{average velocity} = \frac{\Delta x}{\Delta t}, \text{ instantaneous velocity} = \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$





average acceleration =  $\frac{\Delta v}{\Delta t}$ , instantaneous acceleration =  $\lim_{\Delta t \rightarrow 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt} = \frac{d^2x}{dt^2}$

Q 11.1 Pg-613)  $x = 1.5t^4 - 30t^3 + 5t + 10$  Find position, velocity and acc. at  $t=4$

$t=4$   $x = 1.5(4^4) - 30(4^3) + 5(4) + 10 = -66\text{m}$

$v = \frac{dx}{dt} = 6t^3 - 90t^2 + 5$   $t=4$   $v = 149\text{m/s}$

$a = \frac{dv}{dt} = 18t^2 - 180$   $t=4$   $a = 228\text{m/s}^2$

Q 11.6)  $x = 2t^3 - 15t^2 + 24t + 4$  find

a) times when velocity is 0

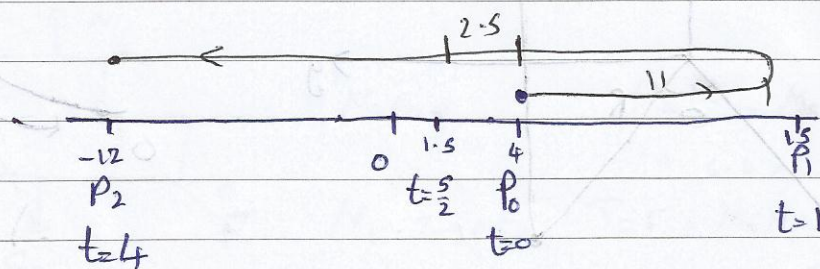
b) position and total distance at  $a=0$

a) initial position  $p_0$  at  $t=0$   $x = 4\text{m}$

$v = \frac{dx}{dt} = 6t^2 - 30t + 24$   $v=0$ ,  $6t^2 - 30t + 24 = 0$   
 $t = 1$  and  $4$  seconds

b) position at  $t=1 = 15\text{m}$

position at  $t=4 = -12\text{m}$



$a = \frac{dv}{dt} = 12t - 30$   $a=0$ ,  $12t - 30 = 0$   $t = \frac{5}{2}$

$x$  at  $t = \frac{5}{2} = 1.5\text{m}$

distance travelled in  $\frac{5}{2}$  seconds =  $11 + 11 + 2.5 = 24.5\text{m}$

